

## CLAIMS

1. A method for synchronizing a plurality of data images in a computer system, the plurality of data images including a primary image and at least one secondary image, the method comprising:

5           receiving a write request from a host computer at a primary image site and at a secondary image site;

          writing to the primary image at the primary image site and attempting to write to the at least one secondary image at the at least one secondary image site; and

10           in the event the write attempt to the at least one secondary image fails, creating a fracture log at the primary image site which is representative of changed regions in the primary image at the primary image site, whereby the log can be used to synchronize the primary image and the secondary image.

2. The method of claim 1, wherein said fracture log comprises a  
15    bitmap identifying the changed regions on at least one disk that has been written to.

3. The method of claim 1, conducted in synchronous mirroring operations.

4. The method of claim 1, further comprising simultaneously updating  
20    the primary image at the primary image site and the at least one secondary image at the at least one secondary image site in response to a write request, and communicating to the host that the update to the primary image at the primary image site and the at least one secondary image at the at least one secondary image site is complete, whereby the fracture log is not created.

25           5. The method of claim 1, wherein: the write request to the at least one secondary image site fails; the fracture log representative of changed regions is created at the primary image site and is representative of changed regions in the image at the primary image site; and the fracture log at the primary image site is used to effect writing to the at least one secondary image at the at least one  
30    secondary image site when it becomes possible to write to the at least one

secondary image site, to ensure that the images at the primary image site and at the at least one secondary image site are synchronized.

6. The method of claim 1, further comprising erasing the fracture log once writing to the at least one secondary image occurs.

5           7. The method of claim 5, further comprising erasing the fracture log once writing to the primary image and to the at least one secondary image occurs.

8. The method of claim 4, wherein the write request fails at the primary image site, and further comprising creating a write intent log which identifies blocks at the primary image site to which writing may have occurred, for  
10       writing of the identified blocks to at least one secondary image, when writing to the primary image site is restored, and in the event writing to the at least one secondary image is not possible, for creating said fracture log at the primary image site for effecting said write request on the at least one secondary image when writing to the at least one secondary image is restored.

15           9. The method of claim 1, wherein said primary image site and said secondary image site comprise storage arrays.

10. The method of claim 1, wherein said host computer is a server, connected through a network comprising a plurality of storage arrays comprised of multiple storage disks, for controlling the operation of the storage arrays.

20           11. The method of claim 1, wherein said synchronizing of data images at the primary image site and at the secondary image site is conducted to allow the computer system to operate in the event one of the primary image sites and the secondary image site fails.

25           12. A computer system for maintaining a plurality of data images in the computer system, the plurality of data images including a primary image and at least one secondary image, the computer system comprising:

non-volatile storage for storing at least the primary image;  
a network interface for accessing the at least one secondary image;  
logic for creating a fracture log which identifies changed regions in  
30       the primary image effected as a result of a write to the primary image, and for

creating the fracture log only if a write request to a primary image and at least one secondary image fails with respect to the secondary image failure; and

write logic for writing to the primary image and to the at least one secondary image to maintain the primary image and the at least one secondary image synchronized, and for writing to the at least one secondary image based on the contents of the fracture log upon the failure of a write request to the at least one secondary image.

13. The computer system of claim 12, wherein said fracture log comprises a bitmap identifying the changed regions on at least one disk that have been effected.

14. The computer system of claim 12, wherein said logic for creating a fracture log is located at a primary image site in which the primary image is maintained, and said write logic is configured for updating the primary image at the primary image site and the at least one secondary image at at least one secondary image site, and for communicating to a host issuing the write request that the update to the primary image at the primary image site, and the at least one secondary image at the at least one secondary image site is complete.

15. The computer system of claim 12, wherein the write logic is configured for using a created fracture log, in the event of a failure upon a write request to write to the at least one secondary image, to write the same changes to the at least one secondary image upon the ability to write being restored, as previously written to the primary image to ensure synchronization between the primary image and the at least one secondary image.

16. The computer system of claim 12, wherein said write logic is configured for erasing the fracture log once writing to the primary image and to the at least one secondary image occurs.

17. The computer system of claim 14, wherein said write logic is configured for erasing the fracture log once writing to the primary image and to the at least one secondary image occurs.

18. The computer system of claim 14, further comprising:

a write intent log in the primary image for identifying regions in the primary image possibly affected by a write request irrespective of whether there was a possible failure to write to the primary image in response to a write request; and

5           said write logic further configured for writing to the secondary image the blocks in the primary image identified by the write intent log as possibly being affected upon the ability to write to the primary image being restored to normal operation.

10           19. The computer system of claim 12, wherein said primary image site and said at least one secondary image site comprise storage arrays.

20. The computer system of claim 19, further comprising a host server for controlling said storage arrays and for issuing write requests to said storage arrays.

15           21. The computer system of claim 12, further configured for continuing to operate with current image data in the event of failure of the primary image site.

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